

Leontopithecus rosalia. By Devra G. Kleiman

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Leontopithecus Lesson, 1840

Leontopithecus Lesson, 1840:184, 200. Type species designated by Pocock, 1917:255, as *Leontopithecus marikina* Lesson.

Marikina Gray (not Lesson), 1843:xviii, 15. Type species by tautonymy *Leontopithecus marikina* Lesson.

Leontocebus Elliot (part, not Wagner, 1840 = *Saguinus Hoffmannsegg*, 1807), 1913, 1:xxxv, 194. Type species designated as *Hapale chrysomelas* Wied (but Miller, 1912:380 had already designated *Midas leoninus* E. Geoffroy = *Saguinus fuscicollis fuscus* Lesson as type of *Leontocebus* Wagner).

Leontideus Cabrera, 1956:52. Renaming of *Leontocebus* Elliot. Type species *Simia rosalia* Linnaeus.

CONTEXT AND CONTENT. Order Primates, Suborder Haplorhini, Infraorder Platyrrhini, Family Callitrichidae. In addition to *Leontopithecus*, this family includes the extant genera *Saguinus*, *Callithrix*, and *Cebuella* (Hershkovitz, 1972, 1977). The genus *Leontopithecus* includes only one living species (Hershkovitz, 1972; Coimbra-Filho and Mittermeier, 1972).

Leontopithecus rosalia (Linnaeus, 1766)

Lion tamarin

[*Simia*] *Rosalia* Linnaeus, 1766:1, 41. Type locality Brazil, restricted to right bank, Rio São João, Rio de Janeiro, by Carvalho, 1965:22.

Midas chrysomelas Kuhl, 1820:51. Type locality Ribeirão das Minhocas, left bank upper Rio dos Ilhéus, Southern Bahia, Brazil.

Jacchus chrysopygus Mikan, 1823:fasc. 3, pl. 1. Type locality Ipanema (= Varnhagen or Bacaetava), São Paulo, Brazil.

[*Jacchus*] *Chrysurus* I. Geoffroy, 1827:520, attributed to Wied and cited as synonym of *chrysomelas*.

[*Jacchus Rosalia*] *Guyannensis* Fischer, 1829:65. Type locality French Guiana (but Eastern Brazilian individual probably transhipped from Cayenne to France—Hershkovitz, 1977).

[*Jacchus Rosalia*] *Brasilensis* Fischer, 1829:65. Type locality not specified.

[*Midas*] *Leontopithecus marikina* Lesson, 1840:200. New name for *Simia rosalia* Linnaeus.

Midas [(*Leontopithecus*)] *ater* Lesson, 1840:203. Renaming of *Jacchus chrysopygus* Mikan.

[*Leontopithecus*] *aurora* Elliot, 1913, 1:182. Lapsus for *L. marikina* Lesson.

Leontocebus leoninus, Pocock (not Humboldt), 1914:898.

CONTEXT AND CONTENT. Context in generic account above. The three kinds of *Leontopithecus* are currently considered subspecies (Hershkovitz, 1972; Coimbra-Filho and Mittermeier, 1973). The taxonomy of *Leontopithecus* has been discussed by Hershkovitz (1977), Coimbra-Filho (1970a) and Coimbra-Filho and Mittermeier (1972). The following key to the subspecies is modified from Hershkovitz (1977):

- 1 Mane and trunk blackish, outer and inner side of thighs and rump contrastingly colored golden to reddish ----- *L. r. chrysopygus*
Mane, at least in front, mostly or entirely golden or reddish, trunk blackish, reddish, golden or buffy, thighs not contrastingly colored ----- 2
- 2 Trunk blackish ----- *L. r. chrysomelas*
Trunk reddish, orange, golden, or buffy ----- *L. r. rosalia*

The species includes three subspecies:

L. r. chrysopygus Mikan, 1823, see above (*ater* Lesson a synonym).

L. r. rosalia Linnaeus, 1766:1, 41, see above (*guyannensis* Fischer,

er, brasiliensis Fischer, *marikina* Lesson, *aurora* Elliot, and *leoninus* Pocock are synonyms).

L. r. chrysomelas Kuhl, 1820:51, see above (*chrysurus* Geoffroy a synonym).

DIAGNOSIS. Lion tamarins are the largest of the callitrichids, with a long silky pelage. The face is almost bare and surrounded by a mane. The hands and digits are extremely long, with a web partially uniting the digits of the hand.

GENERAL CHARACTERS. Weights of captive adult males and females average 710 g (range 600 to 800 g) in *L. r. rosalia* (Hoage, 1978, pers. comm.). There is no sexual dimorphism, although females may average slightly heavier than males during pregnancy. Previously published weights are lower (Hershkovitz, 1977; Coimbra-Filho and Mittermeier, 1972; Napier and Napier, 1967), but some of these weights have combined juveniles and adults, as well as feral and captive-born animals (the latter are heavier). Length of head and body averages 261 mm (200 to 336) and length of tail averages 370 mm (315 to 400) (Hershkovitz, 1977; see also Coimbra-Filho, 1976; Coimbra-Filho and Mittermeier, 1972). The mane is derived from long hairs on the crown, cheeks, and throat and obscures the ears. Coloration of *L. r. rosalia* ranges from the pale golden to rich reddish-golden with occasional orange, brown, or black coloration on the tail and forefeet. *L. r. chrysomelas* and *L. r. chrysopygus* are predominantly black. *L. r. chrysomelas* has golden to reddish-orange on the front of the mane, the lower half of the forelimbs and the proximal half of the dorsal surface of the tail. *L. r. chrysopygus* has varying amounts of reddish-golden coloration on the rump, inner and outer thighs, and base of tail. The glans penis is acorn-shaped (Hershkovitz, 1977). For more complete discussion of diagnostic and general characters as well as color photographs of the three subspecies, see Hershkovitz (1977), Coimbra-Filho and Mittermeier (1973), and Coimbra-Filho (1976). A captive *L. r. rosalia* family at the National Zoological Park is shown in Fig. 1.

DISTRIBUTION. Lion tamarins historically occurred in the lowland forests of southeastern Brazil, in the states of Bahia, Espírito Santo, Rio de Janeiro, and São Paulo (Fig. 2). They are currently extinct in Espírito Santo (Hershkovitz, 1977; Coimbra-Filho and Mittermeier, 1973, 1977). *L. r. chrysopygus* was restricted to the tropical rain forests between the Rio Paranapanema and the Rio Tietê in the state of São Paulo. Since most of the forest has been destroyed, the current range of this form is restricted to the Morro do Diabo State Park (in the westernmost part of São Paulo), with a second remnant population near Gália, São Paulo (22°18'S, 49°34'W) (Hershkovitz, 1977; Coimbra-Filho, 1970a, 1970b, 1976).

L. r. chrysomelas has the most northerly range, and was originally found between the south bank of the Rio das Contas and the north bank of the Rio Belmonte along the Atlantic Coast (14° to 16°S). Currently there are small, scattered populations near Buerarema, Itabuna, Una, and possibly Ilhéus, in the state of Bahia (Hershkovitz, 1977; Coimbra-Filho and Mittermeier, 1973, 1977). Much of the original forest has been logged or has been replaced by cacao and rubber plantations, which are unsuitable for lion tamarins.

L. r. rosalia was historically found in the coastal forests of the states of Rio de Janeiro (formerly Guanabara) and Espírito Santo (23°S, 44°W to 20.5°S, 40.5°W) south of the Rio Doce. The range is now reduced to remnant forests in the Rio São João Basin in Rio de Janeiro, which are scattered and probably total considerably less than 900 km² in area (Coimbra-Filho and Mittermeier, 1977). It is not known how long the ranges of the three subspecies have been isolated. Both *L. r. chrysomelas* and *L. r. rosalia* live at altitudes of less than 300 m, while *L. r. chrysopygus* may range to 700 m. Distribution of *L. rosalia* is discussed further in Hershkovitz (1977), Coimbra-Filho (1970a, 1970b, 1976), and Coimbra-Filho and Mittermeier (1973, 1977).

There is no fossil record.



FIGURE 1. A captive golden lion tamarin family at The National Zoological Park (Photo courtesy of Smithsonian Institution).

FORM. Hershkovitz (1977) provided a complete summary of the morphology of *L. rosalia*, which forms the basis of this section unless otherwise specified. The remarkably different pattern of coloration of the three subspecies of *L. rosalia* has been attributed to a gradual evolutionary bleaching process (Hershkovitz, 1977). Individual differences in coloration and pattern in

L. r. rosalia, and especially the tendency of captive golden lion tamarins to be nearly yellow-white in color, have often been attributed to diets which are deficient in carotenoids and protein (Coimbra-Filho, 1965) or to excessive sunlight (Hershkovitz, 1977). However, captive *L. r. rosalia* acquire a rich, reddish-golden coloration from exposure to sunlight, which also causes a darkening of the facial skin (Kleiman, unpubl.). Coimbra-Filho and Cruz Rocha (1978) described a case of alopecia and depigmentation in a specimen of *L. r. chrysomelas*. Coimbra-Filho and Maia (1979a) described the molting patterns of captive *L. r. rosalia*. The face of *L. rosalia* is naked, with variation in the degree of pigmentation; facial coloration ranges from fleshy to purplish. Hair on the forehead is short and wedge-shaped, unlike the mane which arises from long hair on the crown, cheeks, and throat. The external ear of *L. rosalia* is rounded in form, and becomes concealed as the mane develops in the juvenile. There is a median laryngeal air sac present which is larger in males than females (Hershkovitz, 1977). A sternal apocrine scent gland is present (Epplé and Lorenz, 1967).

The forelimbs are slender and elongate, and the long digits are designed for probing for grubs and insects. The fore and hindlimbs are more equal in length relative to other callitrichids. Limb proportions are as follows: length of humerus \times 100/length of radius, 99 (98 to 103); length of femur \times 100/length of tibia, 96 (94 to 101), length of humerus and radius \times 100/length of femur and tibia, 88 (87 to 90). *L. rosalia* is less of a saltator than other callitrichids, with tendencies toward being a climber. The hand is shorter than the foot and the pollex is not opposable. The digits have sharp, recurved, laterally compressed claws. Relative lengths of digits, from longest to shortest, are: manus 3-4-2-5-1; pes 4-3-5-2-1. The palm is narrow, and the length of the middle finger is more than twice the width of the palm. The vertebral formula is C7, T12, L7, S3-4, Cd22-28 (Hershkovitz, 1977).

Two nipples are present and are axial in position. The milk of *L. r. rosalia* is similar to that of other New World monkeys (Buss, 1975). The penis is acorn-shaped and the penile stem is covered with papillae. The testes may be scrotal or inguinal, position being under some voluntary control. Measurements of testes of two males were 10×9 and 15.5×11 mm. The somewhat pendulous scrotum is unpigmented; greatest scrotal diameter for

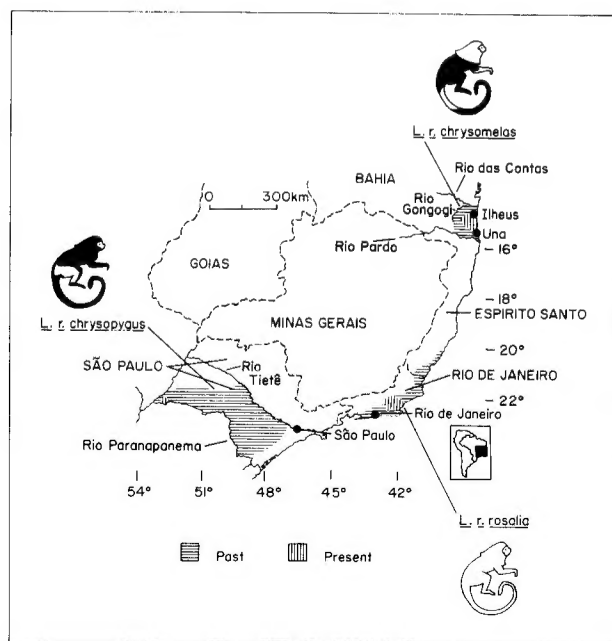


FIGURE 2. Past and present distribution of the three subspecies of *Leontopithecus rosalia* in Brazil. Based on Hershkovitz (1977) and Coimbra-Filho and Mittermeier (1977). Drawing by S. James.



FIGURE 3. Photograph of skull of *L. r. rosalia* (courtesy of Smithsonian Institution). From top: dorsal and ventral views of cranium and ventral view of mandible. Scale is in mm.

a male was 18 mm. The baculum of *L. rosalia* is the most specialized of the callitrichids, with measurements of one individual being 3.0 mm long and 0.9 mm wide. Female external genitalia are unpigmented; the labia majora are more poorly differentiated than in other callitrichids. There are sebaceous and sudoriparous glands in the circumgenital area of both sexes (Hershkovitz, 1977).

The skull of *L. rosalia* (Figs. 3, 4) has been described by DuBrul (1965) and Hershkovitz (1977). The dental formula is $i\ 2/2$, $c\ 1/1$, $p\ 3/3$, $m\ 2/2$, total 32. The upper and lower incisors are comparatively short, and the canines are twice as long as adjacent teeth. The relationship between incisor and canine lengths has resulted in the use of the term "long-tusked" to describe *Leontopithecus* and *Saguinus* and "short-tusked" for *Callithrix* and *Cebuella*, in which the canines and long incisors are approximately the same length. Upper incisors have expanded crowns, with the outer incisor set in an oblique manner and posterior to the inner incisor (Figs. 3, 4). The lower incisors also have transversely expanded crowns, with the lateral incisor club-shaped and larger than the spatulate-shaped central incisor. The upper and lower canines are long and saberlike. Permanent upper and lower premolars are more molariform than in other callitrichids. All upper premolars are distinctly bicuspid with an incipient metacone often present in either or both P3 and P4. Lower premolars are also comparatively well molarized. Sample measurements (in



FIGURE 4. Lateral view of cranium and mandible of skull shown in Fig. 3.

mm) of an upper P2 and lower p2 respectively are: height of crown 3.0, 3.4; length 3.0, 2.9; width 3.3, 2.5. M1 is more than half again as large as the M2 and about a third larger than P4. The trigon basin of the M1 is deeply concave. Both upper molars have well-developed accessories. The lower molars are quadrate and simplified. The deciduous P4 is highly molarized which together with the molarization of the permanent premolars supports the suggestion that the center of mastication has shifted forward (Hershkovitz, 1977).

The greatest length of skull in adults is 50 to 62 mm. *L. rosalia* has four communicating sphenoidal cavitations opening behind in a pair of large sphenoidal fossae, which is unique among higher primates (Hershkovitz, 1977). The mandible outline is intermediate between the V-shape of *Callithrix* and the U-shape of *Saguinus*. The frontal contour is low and the nasal profile slightly concave. The orbits are somewhat square in outline with the interorbital area pneumatized. The auditory bullae are inflated; the dental arcade is between a U- and V-shape. The brain of *L. rosalia* is relatively larger but less complicated than in other callitrichids. Four major sulci have been found on each hemisphere (Hershkovitz, 1977). Some aspects of the muscular system and internal organs of *L. rosalia* are given in Hill (1957). Benirschke and Richart (1963) provide weights of some internal organs.

FUNCTION. Preliminary data on urinary chorionic gonadotropin levels in pregnant females were presented in Kleiman et al. (1978). Bush et al. (1977) provided information on physiologic measures (blood pH and gases, rectal temperature, respiration, and pulse rates) during physical restraint of *L. rosalia*.

ONTOGENY AND REPRODUCTION. As with other callitrichids, both fetuses share the same chorion (Benirschke and Layton, 1969). The placenta is discoidal with vascular anastomoses present, resulting in blood chimerism, a characteristic peculiar to callitrichids. Benirschke and Richart (1963) provided weights of fetuses and a placenta. Gestation was estimated as between 132 and 137 days, based on interbirth intervals (Hershkovitz, 1977; Rabb and Rowell, 1960; Ulmer, 1961); however, observed intervals between copulatory activity and birth suggest that gestation averages 129 days with a range of 125 to 132 days (Kleiman, 1977a; Wilson, 1977). Post-partum matings are most common approximately 3 to 10 days after birth (Snyder, 1974;

Wilson, 1977). Detection of pregnancy is difficult without palpation although the rise in urinary chorionic gonadotropins during weeks 4 to 9 of pregnancy suggests that the Non Human Primate Pregnancy test kit could be used to identify and chart the course of pregnancy (Kleiman et al., 1978). A behavioral estrus, with copulatory activity, is common during pregnancy shortly after the drop in chorionic gonadotropins (about 8 weeks pre-partum) (Kleiman and Mack, 1977). Otherwise, copulatory behavior is infrequent and appears to be confined to the period near ovulation.

The length of the ovarian cycle is unknown, and appears highly variable. However, 50% of observed intervals between peaks of sexual activity were from 14 to 21 days (Kleiman, 1977a), which is within the range of ovarian cycles reported for *Callithrix jacchus* by Hearn (1977). Litter size ranges from one to three, averaging two (Hershkovitz, 1977). In Brazil, births are concentrated in a 6-month period between September and February, after the start of the rainy season (Coimbra-Filho and Mittermeier, 1973; Coimbra-Filho and Maia, 1979b). In the Northern Hemisphere births occur mainly from February to August (Kleiman, 1977a; Hershkovitz, 1977). Both captive and wild individuals in Brazil are rarely reported to bear more than one litter per year, while both wild-caught and captive-born females in the North Temperate Zone may have two litters per year (Kleiman, 1977b).

Neonates are fully furred and with the eyes opened. The fur is usually pale golden and there may be a black band extending frontoparietally which is later obscured as the mane develops. Birth weights average 60.6 g (range 52.1 to 74.6 g); singletons are heaviest and triplets lightest (Hoage, 1978, pers. comm.). Neonatal length of head and body ranges from 100 to 114 mm and length of tail 117 to 143 mm (Hoage, 1978, pers. comm.). Growth rates may be found in Hoage (1978, pers. comm.), DuMond et al. (1979) and Rohrer (1979).

Young cling to the mother from birth, and are able to crawl from her dorsal to ventral surface for nursing. During the first 2 weeks, infants are often asleep or nursing and only gradually increase their visual exploration and manipulation of the environment. Manual and oral manipulation of objects increases rapidly from week 5. Infants first begin to leave carriers for brief periods during weeks 2 to 3 although well coordinated locomotion, such as jumping, leaping, and running is not common until week 8. Play activities become more common as locomotion and coordination improve. Young begin to eat solid food from the parents' hands during week 4, and start to acquire food independently during week 8; weaning occurs by week 12. Young juveniles acquire considerable food from parents and older siblings through food sharing and stealing. From week 10 they begin occasionally to share food with relatives; the major increase in food sharing behavior by older juveniles, however, occurs at ages 25 to 35 weeks, when recently-born younger siblings begin to eat solid food. By week 16, young are approximately one-half of adult weight (Hoage, 1977, 1978; Green, 1979). Signs of sexual maturity, that is, sternal scent marking and back arching, appear between weeks 32 to 40, and are more common in young males than females. Both sexes are sexually inhibited while still within the natal family group, and sibling or parent-offspring conflict may occasionally occur (Kleiman, 1979a). Most males and females are not sexually and socially mature until approximately 18 months of age (Kleiman and Jones, 1977). Other descriptions of development may be found in Ditmars (1933), Altmann-Schönberger, (1965), and Frantz (1963).

The longevity of captive animals has increased with improved care; captive individuals between 10 and 15 years of age often are still reproductively active (Kleiman, 1979b).

ECOLOGY. The sparse information available on the ecology of *L. rosalia* may be found in Coimbra-Filho (1970a, 1970b, 1976) and Coimbra-Filho and Mittermeier (1973, 1977). *L. rosalia* appears to be restricted to primary lowland forest, although little climax forest still exists within its range. Annual rainfall varies from 1100 to 2000 mm, with temperatures averaging 22°C. The wet season occurs from September to March within the range of *L. r. rosalia* and *L. r. chrysopygus*; in the range of *L. r. chrysomelas*, heaviest rains fall from March to June and in November and December. *L. rosalia* is usually found between 3 to 10 m above the ground, in dense vines and epiphytes, which may provide protection from aerial predators. Protection from predation may also be improved by the tendency for groups to sleep in tree holes abandoned by other species. Entrances to these shelters have been found as low as 1.5 m from the ground although most are 11 to 15 m above the ground. Hair deposits found in these

shelters suggest extended usage (Coimbra-Filho, 1977). Coimbra-Filho (1977) captured *L. rosalia* by trapping groups in tree holes. Lion tamarins feed mainly on fruits, insects and occasionally small vertebrates. Insects of the orders Blattaria, Orthoptera, Homoptera, Lepidoptera, Hemiptera, and Coleoptera (especially larvae) are taken. Snails, lizards (*Anolis* spp.), and possibly bird eggs and hatchlings may also be eaten. Preferred fruits are soft, sweet and pulpy; species eaten include *Ficus* spp., *Inga* spp., *Tapirira guianensis*, *Cecropia* sp., *Posqueria latifolia*, and several forms of Myrtaceae including *Marlierea* sp., *Eugenia* sp., and *Campomanesia guabiroba*.

Group size varies from two to eight, with three to four being most common, although feeding aggregations of 15 to 16 have been reported. Groups are probably composed of a single reproductive pair, their offspring from one or two litters, and perhaps other relatives, thus forming a nuclear or extended family. There are no data on when juvenile dispersal occurs and the mechanisms of pair bond formation, although these phenomena have been examined in captivity (Kleiman 1978, 1979a). Home range size is not known. Lion tamarins are likely to be territorial, based on the high levels of intrasexual aggression observed in neighboring groups in captivity (Snyder, 1974). *L. r. chrysomelas* may form mixed-species associations with *Callithrix jacchus penicillata* (Coimbra-Filho, 1970b).

The three subspecies of *L. rosalia* are near extinction because of human activity within their range, the major factor being the near total destruction of the primary forest. Current estimates of the population sizes of the three subspecies are: golden lion tamarin (*L. r. rosalia*), about 100 to 200 animals; golden-headed lion tamarin (*L. r. chrysomelas*), about 200 animals; golden-rumped lion tamarin (*L. r. chrysopygus*), about 200 animals (Coimbra-Filho and Mittermeier, 1977). This species is in serious jeopardy, and may not survive. The export of specimens to zoos and as pets, especially *L. r. rosalia*, whose range is within one of the most densely populated areas of Brazil, may also have contributed to the species decline. Since the mid-1960's, conservation efforts have concentrated on three approaches: (1) the development of secure reserves, (2) the establishment of a captive breeding program in Brazil (the Tijuca Bank) to provide specimens for a reintroduction program, and (3) the implementation of an international cooperative breeding program to increase the captive population outside of Brazil. These topics are covered in several contributions in Bridgwater (1972) and in Hill (1970), Perry (1972), Magnanini (1977), Magnanini et al. (1975), Kleiman (1977b), Kleiman and Jones (1977), and Coimbra-Filho and Mittermeier (1977).

An *International Studbook* for *L. r. rosalia*, which documents changes in the captive population, is prepared annually by D. G. Kleiman. Of the three conservation programs, the poorest success has been achieved in the establishment and protection of secure reserves within Brazil. Although reserves now exist for all three subspecies (Coimbra-Filho and Mittermeier, 1977), only the Morro do Diabo State Park may be sufficiently large to maintain a viable population of *L. r. chrysopygus* without human interference. There are currently no firm estimates of population sizes within reserves for *L. rosalia*. However, Coimbra-Filho and Mittermeier (1978) do not recommend a reintroduction program in the near future. Captive breeding of the three subspecies at the Tijuca Biological Bank in Rio de Janeiro, directed by A. F. Coimbra-Filho, has been only partly successful, with many captive births but also with losses from unknown causes (Coimbra-Filho, pers. comm.). Outside Brazil, breeding success has improved the status of the captive population of *L. r. rosalia*. Based on the *International Studbook*, the numbers of captive golden lion tamarins increased from 69 in 1972, to 74 in 1975, and to 120 in 1978 (excluding an additional 18 specimens in South Africa in 1978) (Kleiman, 1979b) after a continuous annual decline in numbers of captive specimens between 1968 and 1972, when Brazil imposed a ban on the species export (Perry et al., 1975).

Care and maintenance techniques may be found in DuMond (1971, 1972) and Coimbra-Filho and Magnanini (1972). Hand-rearing and reintroduction techniques for hand-raised young may be found in DuMond et al. (1979) and Rohrer (1979). Captive specimens are susceptible to infection by *Herpes* viruses, rubeola, the bacteria *Pseudomonas*, *Klebsiella*, *Salmonella*, and to infestation with parasites such as *Prosthonorchis* and *Rictularia* (Hershkovitz, 1977). Due to its extreme rarity, *L. rosalia* has not been used in biomedical research.

BEHAVIOR. The following account is based mainly on observations of captive *L. r. rosalia*. *L. rosalia* is primarily arboreal. Individuals walk, run, and climb on branches using a quadrupedal gait. They frequently spring or leap from branch to

branch and cling to and leap from vertical surfaces. In captivity, lion tamarins descend to the ground to explore and forage on the substrate. They apparently prefer to move in a horizontal plane (Coimbra-Filho and Magnanini, 1972). *L. rosalia* is diurnal, awaking near sunrise and retiring into nest boxes at dusk. A midday period of rest is common.

The basic social group appears to be a nuclear or extended family, and intrasexual aggression among unfamiliar adults is high, especially if an animal of the opposite sex is also present (Eppler, 1967; Snyder, 1974). Females may be more aggressive than males (Snyder, 1974; Kleiman, 1979a). Within both artificially composed and natural family groups, only a single male and female reproduce (Snyder, 1974; Kleiman, 1978), even though all members of a group may interact socially. Dominance interactions are infrequent within established groups, and outbreaks of aggression are unpredictable, often occurring when the reproductive female approaches estrus (Kleiman, 1979a). One sign of tension is the arch back display whose function and contextual occurrence have been analyzed by Rathbun (1979). Groups of lion tamarins exhibit frequent tactile contact with allogrooming and huddling being two major social activities. Allogrooming movements are typically primate in form, with the hands being used to part the fur and both hands and mouth used to remove detritus. Males groom females more than the reverse (Kleiman, 1977a). Allosniffing is commonly seen, with the male sniffing the female more frequently, especially in the anogenital region, as she approaches estrus (Snyder, 1974; Kleiman, 1977a). Males also increase the frequency of other affiliative behaviors, such as grooming and huddling, as the female nears estrus. By contrast, females exhibit an increase in affiliative behaviors directed towards males approximately 2 to 4 days before the males' peak sexual interest (Kleiman, 1977a).

Copulatory behavior is primate in form with the male mounting and clasping the female in the mid-section anterior to the hindlimbs while keeping the hindfeet clasped on a branch or other surface. Shallow rapid thrusting movements precede intromission. Several intromissions may precede an ejaculation. Ejaculation is difficult to discern but may be recognized by (a) the female vocalizing and/or looking back to the male, (b) a prolonged thrust during intromission, (c) licking of the genitalia by the male and female after separation, and (d) a quiescent period without attempted mounts following separation (Snyder, 1974; Kleiman, 1977a). Copulatory activity, although infrequent, is more common in newly established pairs than in pairs with long-term bonds and with offspring (Kleiman, 1977c).

Both males and older juveniles participate in parental care activities (Hoage, 1977, 1978, pers. comm.; Frantz, 1963; Altmann-Schönberger, 1965; Snyder, 1974; Green, 1979). Immediately post-partum, the female carries the neonates exclusively and may be aggressive to family members who approach (Hoage, 1977; Snyder, 1974). Between 2 and 17 days post-partum, the young are first transferred to the male, with triplets usually being transferred earlier than twins or singletons (Hoage, 1977; Kleiman, 1977c). First transfers are accomplished by persistent interest by family members who approach, press the ventrum against the young, and manipulate young with the hands. Such transfers are facilitated by the mother's developing intolerance, expressed by scratching at the infants, and rubbing her back (young are carried dorsally) against surfaces. Hoage (1977, 1978) reports that: (1) mothers are the principal carriers of young through week 3, with fathers carrying more than mothers thereafter; (2) juvenile females begin carrying young earlier (week 2) than juvenile males (week 3), but juveniles of both sexes rarely carry younger siblings after week 8; (3) there is a tendency for parents (and possibly older juveniles) to preferentially carry infants of their own sex; and (4) primiparous parents with previous exposure to infants are most successful in rearing their own neonates, suggesting that experience with infants during the juvenile phase is important for successful reproduction.

Hoage (1978, pers. comm.) charted the social development of young lion tamarins, especially the ontogeny of food-sharing, an unusual behavior first reported by Wilson (1976) and further analyzed by Brown and Mack (1978) and Green (1979) with respect to the accompanying visual and vocal signals. Play consists mainly of chasing, grappling, and wrestling, and is observed primarily in juveniles (Snyder, 1974; Hoage, 1978, pers. comm.). Visual signals are not as complex as in Old World monkeys, but include agonistic patterns such as arched back displays (Rathbun, 1979), stares, open mouth threats, and piloerection. Tongue-flicking is a display seen mainly in the context of sexual behavior (Eppler, 1967; Snyder, 1974). Vocalizations are complex; they consist of whines, trills, clucks, and non-tonal sounds, which

can be combined to form more complex calls (McLanahan and Green, 1977; Green, 1979). There are few sex differences in the frequency or types of vocalizations. Of special interest is the Long Call, composed of trills, whines, and clucks, which bonded pairs produce as a duet. This call may function in spacing groups in the wild. Green (1979) and McLanahan and Green (1977) analyzed the contextual occurrence of the different vocalizations, and Green (1979) described vocal ontogeny.

Olfactory communication is mainly accomplished through scent marking with the sternal and circumgenital glands (Eppler and Lorenz, 1967; Eppler, 1972). Adult reproductive males and females scent mark at similar frequencies; young females rarely scent mark until paired, but young males begin scent marking while still in the natal family group. Adult reproductive males scent mark at relatively constant frequencies; breeding females, on the other hand, exhibit fluctuations, including low levels at estrus and after birth and higher levels during pregnancy (Mack and Kleiman, 1978; Kleiman and Mack, 1980).

GENETICS. The diploid number of chromosomes is 46. There are 4 metacentric, 28 submetacentric, and 12 acrocentric chromosomes. The X chromosome is submetacentric and the Y is metacentric (Hsu and Hampton, 1970). Five hybrids of *L. r. rosalia* and *L. r. chrysomelas* from three litters (none of which survived) were intermediate in color pattern between the parental types, although the color pattern of each hybrid differed (Coimbra-Filho and Mittermeier, 1976). Captive-born *L. rosalia* have been found with defects of the diaphragm, resulting in the migration of liver, stomach, and intestines into the chest region. The distribution of the defect in the captive population strongly suggests a genetic basis, but it is not the result of inbreeding of captive individuals (Bush et al., in press).

REMARKS. *L. r. rosalia* is often referred to as the golden marmoset. Other common names for the species are maned marmoset and silky marmoset. I am grateful to C. Handley and R. Thorington for assistance with the synonymies. S. James prepared the distribution map, and V. Garber and G. Hill typed the manuscript.

LITERATURE CITED

- Altmann-Schönberger, D. 1965. Beobachtungen über Aufzucht und Entwicklung des Verhaltens beim Grossen Löwenaffen, *Leontocebus rosalia*. Zool. Gart., 31:227-239.
- Benirschke, K., and W. Layton. 1969. An early twin blastocyst of the golden lion marmoset, *Leontocebus rosalia* L. Folia Primat., 10:131-138.
- Benirschke, K., and R. Richart. 1963. The establishment of a marmoset breeding colony and its four pregnancies. Lab. Anim. Care, 13:70-83.
- Bridgwater, D. D. (ed.). 1972. Saving the lion marmoset. Wild Animal Propagation Trust, Wheeling, West Virginia, 223 pp.
- Brown, K., and D. S. Mack. 1978. Food sharing among captive *Leontopithecus rosalia*. Folia Primat., 29:268-290.
- Bush, R. M., R. Custer, J. Smeller, and L. M. Bush. 1977. Physiologic measures of nonhuman primates during physical restraint and chemical immobilization. J. Amer. Vet. Med. Assoc., 171:866-869.
- Bush, R. M., et al. In press. Diagnosis and repair of familial diaphragmatic defects in golden lion tamarins. J. Amer. Vet. Med. Assoc.
- Buss, D. H. 1975. Composition of milk from a golden lion marmoset. Lab. Primate News, 14:17-18.
- Cabrera, A. 1956. Sobre la identificación de *Simia leonina* Humboldt (Mammalia, Primates). Neotropica, 2:49-53.
- Carvalho, C. T. de. 1965. Comentários sobre os mamíferos descritos e figurados por Alexandre Rodrigues Ferreira em 1790. Arq. Zool., São Paulo, 12:7-70.
- Coimbra-Filho, A. F. 1965. Breeding lion marmosets at Rio de Janeiro Zoo. Internat. Zoo Yearb., 5:109-110.
- 1970a. Acerca da redescoberta de *Leontideus chrysopygus* (Mikan, 1823) e apontamentos sobre sua ecologia (Callitrichidae, Primates). Rev. Brasil. Biol., 30:609-615.
- 1970b. Considerações gerais e situação atual dos micoss-leões escuros, *Leontideus chrysomelas* (Kuhl, 1820) e *Leontideus chrysopygus* (Mikan, 1823) (Callitrichidae, Primates). Rev. Brasil. Biol., 30:249-268.
- 1976. *Leontopithecus rosalia chrysopygus* (Mikan, 1823), o mico-leão do Estado de São Paulo (Callitrichidae, Primates). Silvic. São Paulo, 10:1-36.
- 1977. Natural shelters of *Leontopithecus rosalia* and some ecological implications (Callitrichidae: Primates). Pp. 79-89, in The biology and conservation of the Callitrichidae (D. G.

- Kleiman, ed.). Smithsonian Inst. Press, Washington, D.C., 354 pp.
- Coimbra-Filho, A. F., and N. da Cruz Rocha. 1978. Acérea de disfunção pigmentar em *Leontopithecus rosalia chrysomelas* (Kuhl, 1820), seu tratamento e recuperação (Callitrichidae, Primates). Rev. Brasil. Biol., 38:165-170.
- Coimbra-Filho, A. F., and A. Magnanini. 1972. On the present status of *Leontopithecus* and some data about new behavioural aspects and management of *L. rosalia rosalia*. Pp. 59-69, in *Saving the lion marmoset* (D. D. Bridgwater, ed.). Wild Anim. Propagation Trust, Wheeling, West Virginia, 223 pp.
- Coimbra-Filho, A. F., and A. de A. Maia. 1979a. O processo da muda dos pêlos em *Leontopithecus r. rosalia* (Linnaeus, 1766) (Callitrichidae, Primates). Rev. Brasil. Biol., 39:83-93.
- 1979b. A sazonalidade do processo reprodutivo em *Leontopithecus rosalia* (Linnaeus, 1766) (Callitrichidae, Primates). Rev. Brasil. Biol., 39:643-651.
- Coimbra-Filho, A. F., and R. A. Mittermeier. 1972. Taxonomy of the genus *Leontopithecus* Lesson, 1840. Pp. 7-22, in *Saving the lion marmoset* (D. D. Bridgwater, ed.). Wild Anim. Propagation Trust, Wheeling, West Virginia, 223 pp.
- 1973. Distribution and ecology of the genus *Leontopithecus* Lesson, 1840 in Brazil. Primates, 14:47-66.
- 1976. Hybridization in the genus *Leontopithecus*, *L. r. rosalia* (Linnaeus, 1766) \times *L. r. chrysomelas* (Kuhl, 1820) (Callitrichidae, Primates). Rev. Brasil. Biol., 36:129-137.
- 1977. Conservation of the Brazilian lion tamarins (*Leontopithecus rosalia*). Pp. 59-94, in *Primate conservation* (Prince Rainier and G. H. Bourne, eds.). Academic Press, New York, 658 pp.
- 1978. Reintroduction and translocation of lion tamarins: A realistic appraisal. Pp. 41-48, in *Biology and behaviour of marmosets* (H. Rothe, H. J. Wolters, and J. P. Hearn, eds.). Eigenverlag H. Rothe, Göttingen, 301 pp.
- Ditmars, R. L. 1933. Development of the silky marmoset. Bull. New York Zool. Soc., 36:175-176.
- DuBrul, E. L. 1965. The skull of the lion marmoset, *Leontideus rosalia* Linnaeus. Amer. J. Phys. Anthropol., 23:261-276.
- DuMond, F. 1971. Comments on minimum requirements in the husbandry of the golden marmoset (*Leontideus rosalia*). Lab. Primate Newsl., 10:30-37.
- 1972. Recommendations for a basic husbandry program for lion marmosets. Pp. 120-136, in *Saving the lion marmoset* (D. D. Bridgwater, ed.). Wild Anim. Propagation Trust, Wheeling, West Virginia, 223 pp.
- DuMond, F. V., B. L. Hoover, and M. A. Norconk. 1979. Hand-feeding parent-reared golden lion tamarins, *Leontopithecus r. rosalia*, at Monkey Jungle. Internat. Zoo Yearb., 19:155-158.
- Elliot, D. G. 1913. A review of the primates. Amer. Mus. Nat. Hist., New York, 1:1-316.
- Epplé, G. 1967. Vergleichende Untersuchungen über Sexual- und Sozialverhalten der Krallenaffen (Hapalidae). Folia Primat., 7:37-65.
- 1972. Social communication by olfactory signals in marmosets. Internat. Zoo Yearb., 12:36-42.
- Epplé, G., and R. Lorenz. 1967. Vorkommen, Morphologie und Funktion der Sternaldrüse bei den Platyrrhini. Folia Primat., 7:98-126.
- Fischer, J. B. 1829. Synopsis mammalium. J. G. Cottae, Stuttgart, 752 pp. (not seen)
- Frantz, J. 1963. Beobachtungen bei einer Löwenaffen—Aufzucht. Zool. Gart., 28:115-120.
- Geoffroy, I. 1827. Oustiti-Jacchus. Dict. Classique. Hist. Nat., 12:512-520.
- Gray, J. E. 1843. List of the specimens of Mammalia in the collection of the British Museum. British Mus. Nat. Hist., London, 216 pp.
- Green, K. M. 1979. Vocalizations, behavior, and ontogeny of the golden lion tamarin, *Leontopithecus rosalia rosalia*. Unpub. D.Sc. dissert. Johns Hopkins University, Baltimore, Maryland.
- Hearn, J. P. 1977. The endocrinology of reproduction in the common marmoset, *Callithrix jacchus*. Pp. 163-171, in *The biology and conservation of the Callitrichidae* (D. G. Kleiman, ed.). Smithsonian Inst. Press, Washington, D.C., 354 pp.
- Hershkovitz, P. 1972. Notes on New World monkeys. Internat. Zoo Yearb., 12:3-12.
- 1977. Living New World monkeys (Platyrrhini) with an introduction to primates. Univ. of Chicago Press, Chicago, 1:1-1117.
- Hill, C. A. 1970. The last of the golden marmosets. Zoonoos, 43:12-17.
- Hill, W. C. O. 1957. Primates. Comparative anatomy and taxonomy, III. Pithecoidea: Platyrrhini (families Hapalidae and Callimiconidae). Edinburgh Univ. Press, Edinburgh, 354 pp.
- Hoage, R. J. 1977. Parental care in *Leontopithecus rosalia rosalia*: Sex and age differences in carrying behavior and the role of prior experience. Pp. 293-305, in *The biology and conservation of the Callitrichidae* (D. G. Kleiman, ed.). Smithsonian Inst. Press, Washington, D.C., 354 pp.
- 1978. Biosocial development in the golden lion tamarin, *Leontopithecus rosalia rosalia* (Primates: Callitrichidae). Unpubl. Ph.D. dissert., Univ. of Pittsburgh, Pittsburgh, Pennsylvania.
- Hoffmannsegg, G. von. 1807. Beschreibung vier Affenartiger Thiere aus Brasilian. Mag. Gesellsch. Naturf. Fr., Berlin, 1:83-104.
- Hsu, T. C., and S. H. Hampton. 1970. Chromosomes of Callitrichidae with special reference to an XX/XO sex chromosome system in Goeldi's marmosets (*Callimico goeldii*, Thomas, 1904). Folia Primat., 13:183-195.
- Kleiman, D. G. 1977a. Characteristics of reproduction and sociosexual interactions in pairs of lion tamarins (*Leontopithecus rosalia*) during the reproductive cycle. Pp. 181-190, in *The biology and conservation of the Callitrichidae* (D. G. Kleiman, ed.). Smithsonian Inst. Press, Washington, D.C., 354 pp.
- 1977b. Progress and problems in lion tamarin, *Leontopithecus rosalia rosalia*, reproduction. Internat. Zoo Yearb., 17:92-97.
- 1977c. Monogamy in mammals. Quart. Rev. Biol., 52:39-69.
- 1978. The development of pair preferences in the lion tamarin (*Leontopithecus rosalia*): Male competition or female choice? Pp. 203-208, in *Biology and behaviour of marmosets* (H. Rothe, H. J. Wolters, and J. P. Hearn, eds.). Eigenverlag H. Rothe, Göttingen, 301 pp.
- 1979a. Parent-offspring conflict and sibling competition in a monogamous primate. Amer. Nat., 114:753-760.
- 1979b. 1978 International Studbook: Golden lion tamarin, *Leontopithecus rosalia*. Nat. Zool. Park, Washington, D.C.
- Kleiman, D. G., D. W. Gracey, and G. D. Hodgson. 1978. Urinary chorionic gonadotropin levels in pregnant golden lion tamarins: Preliminary observations. J. Med. Primatol., 7:333-338.
- Kleiman, D. G., and M. Jones. 1977. The current status of *Leontopithecus rosalia* in captivity with comments on breeding success at the National Zoological Park. Pp. 215-218, in *The biology and conservation of the Callitrichidae* (D. G. Kleiman, ed.). Smithsonian Inst. Press, Washington, D.C., 354 pp.
- Kleiman, D. G., and D. S. Mack. 1977. A peak in sexual activity during mid-pregnancy in the golden lion tamarin, *Leontopithecus rosalia* (Primates: Callitrichidae). J. Mamm., 58:657-660.
- 1980. The effects of age, sex, and reproductive status on scent marking frequencies in the golden lion tamarin (*Leontopithecus rosalia*). Folia Primat., 33:1-14.
- Kuhl, H. 1820. Beiträge zur Zoologie und vergleichenden Anatomie. Hermann, Frankfurt am Main, 152 pp.
- Lesson, R.-P. 1840. Species des mammifères: Bimanes et quadrumanes; suivi d'un mémoire sur les Oryctéropes. J. B. Baillière, Paris, 291 pp. (not seen)
- Linnaeus, C. 1766. Systema Naturae. 12th ed. L. Salvii, Uppsala, 1:1-532.
- Mack, D. S., and D. G. Kleiman. 1978. Distribution of scent marks in different contexts in captive lion tamarins, *Leontopithecus rosalia* (Primates). Pp. 181-188, in *Biology and behaviour of marmosets* (H. Rothe, H. J. Wolters, and J. P. Hearn, eds.). Eigenverlag H. Rothe, Göttingen, 301 pp.
- Magnanini, A. 1977. Progress in the development of Poços das Antas Biological Reserve for *Leontopithecus rosalia rosalia* in Brazil. Pp. 131-136, in *The biology and conservation of the Callitrichidae* (D. G. Kleiman, ed.). Smithsonian Inst. Press, Washington, D.C., 354 pp.
- McLanahan, E. B., and K. M. Green. 1977. The vocal repertoire and an analysis of the contexts of vocalization in *Leontopithecus rosalia*. Pp. 251-269, in *The biology and conservation of the Callitrichidae* (D. G. Kleiman, ed.). Smithsonian Inst. Press, Washington, D.C., 354 pp.
- Magnanini, A., et al. 1975. The Tijuca bank of lion marmosets, *Leontopithecus rosalia*: A progress report. Internat. Zoo Yearb., 15:284-287.

- Mikan, J. C. 1823. *Delectus florae et faunae Brasiliensis*. A. Strauss, Vienna, 54 pp. (not seen)
- Miller, G. S., Jr. 1912. List of North American land mammals. *Bull. U.S. Natl. Mus.*, 79:1-455.
- Napier, J. R., and P. H. Napier. 1967. A handbook of living primates. Academic Press, New York, 456 pp.
- Perry J. 1972. In danger—golden lion marmosets. *Smithsonian Mag.*, 3(9):49-53.
- Perry, J., D. D. Bridgwater, and D. L. Horseman. 1975. Captive propagation—a progress report. Pp. 361-372, in *Breeding endangered species in captivity* (R. D. Martin, ed.). Academic Press, New York, 420 pp.
- Pocock, R. I. 1914. On the facial vibrissae of mammals. *Proc. Zool. Soc. Lond.*, pp. 889-912. (not seen)
- 1917. The genera of Hapalidae (marmosets). *Ann. Mag. Nat. Hist.*, ser. 8, 20:247-258.
- Rabb, G. B., and J. E. Rowell. 1960. Notes on reproduction in captive marmosets. *J. Mamm.*, 41:401.
- Rathbun, C. D. 1979. Description and analysis of the arch display in the golden lion tamarin, *Leontopithecus rosalia rosalia*. *Folia Primat.*, 32:125-148.
- Rohrer, M. A. 1979. Hand-rearing golden lion marmosets, *Leontopithecus rosalia*, at the Oklahoma City Zoo. *Anim. Keeper's Forum*, 6:33-39.
- Snyder, P. A. 1974. Behavior of *Leontopithecus rosalia* (golden lion marmoset) and related species: A review. *J. Human Evol.*, 3:109-122.
- Ulmer, F. A. 1961. Gestation period of the lion marmoset. *J. Mamm.*, 42:253-254.
- Wagner, J. A. 1840. Die Säugthiere in Abbildungen nach des Natur, mit Beschreibungen von Dr. Johann Christian Daniel von Schreber. Fortgesetzt von Dr. Johann Andreas Wagner. Supp. 1-4, 1:1-551. T. O. Weigel, Leipzig. (not seen)
- Wilson, C. G. 1976. Food sharing behavior in primates: Another species added. *Ark. Acad. Sci. Proc.*, 30:95-96.
- 1977. Gestation and reproduction in golden lion tamarins. Pp. 191-192, in *The biology and conservation of the Callitrichidae* (D. G. Kleiman, ed.). Smithsonian Inst. Press, Washington, D.C., 354 pp.
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